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Helminths of the Opossum, *Didelphis virginiana,* in Southern Illinois, with a Compilation of All Helminths Reported from This Host in North America

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ABSTRACT: Twelve species of helminths were recovered from 46 opossums, *Didelphis virginiana,* in southern Illinois. These species and prevalence of infection are as follows: *Brachylaima virginiana* (32.6%), *Capillaria didelphis* (17.4%), *Capillaria longicauda* (52.2%), *Cruzia americana* (78.3%), *Didelphodiplostomum variabile* (21.7%), *Echinostoma trivolvis* (4.30%), *Longistriata didelphis* (63.0%), *Mesocestoides latus* (15.2%), *Oligacanthorhynchus tortuosa* (17.4%), *Paragonimus westermani* (6.52%), *Physaloptera turgida* (100%), and *Rhopalias macracanthus* (15.2%). Of these helminthic infections, the mean intensity was greatest in *Didelphodiplostomum variabile* (66.9 specimens per infected host) and *Cruzia americana* (50.0 specimens per infected host). In addition, a report of all the helminths known to infect this host is included.

KEY WORDS: opossum, *Didelphis virginiana,* helminths, survey.

The opossum, *Didelphis virginiana* Kerr, 1792, the only member of the family Didelphidae found north of Mexico, occurs from southern Canada through much of the contiguous United States, into Mexico and Costa Rica (Gardner, 1982). At one time, the Virginia opossum was considered to be a subspecies of *D. marsupialis*; however, since revision of the genus by Gardner (1973), the Virginia opossum has been considered distinct. The two species are sympatric from northeastern Mexico to northwestern Costa Rica (Gardner, 1982), but only the helminths of *D. virginiana* are considered here.

One can infer that, due to the apparent success as a species, *D. virginiana* has expanded both its population and range. This expansion is primarily due to the wide array of acceptable habitats, its high reproductive potential, and omnivorous diet (Stieglitz and Klimstra, 1962). In addition, the opossum is a hardy creature, and it seems to adapt to heavy parasitic infections quite well. Remarkably few species of helminths observed in this study caused any overt tissue damage. However, the opossum is a short-lived animal; few live longer than 2 yr (Hamilton, 1963). The question of whether or not helminths affect the short life span of the opossum has not been fully investigated. Therefore, in light of this information, the aim of this study was twofold: (a) to examine both the prevalence and intensity of the parasites that infect this host in southern Illinois, and (b) to provide an annotated list of the helminths previously reported in this host.

Materials and Methods

Forty-six opossums, *Didelphis virginiana,* were collected between September 1992 and January 1993 in the following Illinois counties, with quantities in parentheses: Jackson (14), Saline (12), Union (2), and Washington (18). Opossums were gathered by means of road kills and live trapping and through local hunters during the trapping season.

After euthanasia, the hosts were eviscerated, and the organs were separated and placed into containers filled with normal saline. The esophagus, stomach, small intestine, large intestine, body cavity, and lungs were then examined with a dissecting microscope. All parasites were prepared for study utilizing standard parasitological procedures as outlined by Schmidt (1988). Trematodes and cestodes were fixed in alcohol–formalin–acetic acid, stained in Harris' hematoxylin, dehydrated, cleared in beechwood creosote, and mounted in Canada balsam. Nematodes were fixed in hot 70% ethanol and cleared in a 5% glycerine/95% ethanol solution. The ethanol was allowed to evaporate, and they were studied as temporary mounts in 100% glycerine. Mature acanthocephalans were chilled in physiologic saline in order to evert the proboscis, fixed in formalin, and studied without the aid of a permanent mount.

The terms used in this study, including prevalence, intensity, and range of intensity, follow the definitions outlined by Margolis et al. (1982). Specimens have also been deposited in the USNM Helminthological Collection, USDA, Beltsville, Maryland 20705.

Results and Discussion

Five nematode, 5 trematode, 1 acanthocephalan, and 1 cestode species were recovered from 46 hosts. The species, respective location within the hosts, prevalence, mean intensity, and range of infection are listed in Table 1. Every host had

Table 1. Helminths recovered from 46 opossums, *Didelphis virginiana*, in southern Illinois.

Species	Anatomical location	Prevalence	Mean intensity	Range of infection	USNM Helm. Coll. No.
Acanthocephala					
Oligacanthorhynchus tortuosa	Small intestine	17.4%	8.5	1–33	83346
Cestoda					
Mesocestoides latus	Small intestine	15.2%	5.4	1–10	83340
Nematoda					
Capillaria didelphis	Lungs	17.4%	2.8	1–5	83351
Capillaria longicauda	Esophagus	52.5%	1.7	1–4	83350
Cruzia americana	Large intestine	78.3%	50.0	1–200	83349
Longistriata didelphis	Small intestine	63.0%	17.0	1–52	83348
Physaloptera turgida	Stomach	100.0%	18.1	4–60	83347
Larval nematode (unidentified)	Coelomic adipose tissue	8.7%	1.6	1–2	83352
Trematoda					
Brachylaima virginiana	Small intestine	32.6%	15.6	1–32	83341
Didelphodiplostomum variabile	Small intestine	21.7%	66.9	1–500	83342
Echinostoma trivolvis	Small intestine	4.3%	2.0	1–3	83343
Paragonimus westermani	Lungs	15.2%	13.8	2–12	83345
Rhodpalias macracanthus	Small intestine	15.2%	13.8	1–36	83344

at least 1 infection, but the highest prevalence resulted from nematode parasites (100%), followed by trematodes (63%), acanthocephalans (17%), and finally cestodes (15%). In addition, as shown in Table 2, it can be demonstrated from the literature that nematodes are more prevalent than trematodes, and cestodes are roughly equivalent to acanthocephalans in prevalence. The latter 2 groups are considerably less prevalent than the former groups. The present study reflected a similar trend.

Larval nematodes, most likely third-stage larvae, were recovered from the adipose tissue surrounding the right kidney in 4 hosts. These larvae were undergoing a molt in this region when they were discovered; however, the exact identification was impossible to determine. Thus, 11 genera comprising 12 species of helminths were recovered from the 46 opossums examined from southern Illinois. A brief discussion of each of these species is presented.

Acanthocephala

Oligacanthorhynchus tortuosa (Leidy, 1850) Schmidt, 1972

Oligacanthorhynchus tortuosa caused the most overt harm of all the helminthic infections observed in this survey. The particular opossum with 33 worms had almost complete mechanical obstruction of the small intestine and seemed to have smaller fat reserves than most of the hosts examined. Opossums are known to accumulate large quantities of fat, and this host in comparison to the others appeared to be malnourished.

Oligacanthorhynchus tortuosa attachment to the intestinal mucosa produces a small nodule that was demonstrated in many hosts. Babero (1957) observed that this parasite caused destruction of the mucosal and submucosal layers of the intestinal tract, and the penetration of the proboscis into the intestinal lining is the main cause for this necrosis.

Oligacanthorhynchus tortuosa was originally reported from the opossum by Leidy in 1850 (Van Cleave, 1953). Other investigators have recovered this helminth from Illinois, Georgia, Colorado, Arkansas, and Washington. Despite these scattered and infrequent reports, this author believes that *O. tortuosa* is a rather common parasite of the opossum, because it has been reported from widely distributed localities throughout this animal's range.

Cestoda

Mesocestoides latus Mueller, 1927

The presence of *M. latus* caused little gross tissue destruction, for there was no visible host reaction at the attachment sites. There have been numerous reports of 2 species in this genus within the Virginia opossum: *M. latus* and *M. var-*

Table 2. Helminths recorded from *Didelphis virginiana* in North America.

Species	Anatomical location	Geographic locality	Reference
Acanthocephala			
Centrorynchus sp. Luhe, 1911	Small intestine	North Carolina	Miller and Harkema, 1970
Centrorhynchus wardae Holloway, 1958	Small intestine	Arkansas	Richardson, 1993
Macracanthorhynchus ingens (Linstow, 1879) Meyer, 1932	Small intestine	North Carolina	Sherwood et al., 1969
		New Jersey	Fahnestock, 1985
Oligacanthorhynchus tortuosa (Leidy, 1850) Schmidt, 1972	Small intestine	Illinois	Babero, 1957
		Georgia	Babero, 1960
		Colorado	Krupp and Quillin, 1964
		Georgia	Stewart and Dean, 1971
		Illinois	Wong et al., 1979
		Arkansas	Richardson, 1993
		Washington	Richardson, 1993
		Illinois	Present study
Oligacanthorhynchus tumida (Van Cleave, 1947) Schmidt, 1972	Small intestine	Oklahoma	Van Cleave, 1947
		Pennsylvania	Blumenthal and Kirkland, 1976
Cestoda			
Anoplocephala sp. Blanchard, 1848	Small intestine	Colorado	Krupp and Quillin, 1964
Hymenolepis sp. Weinland, 1858	Small intestine	Illinois	Leigh, 1940
		Colorado	Krupp and Quillin, 1964
Mesocestoides sp. Vaillant, 1863	Small intestine	Louisiana	Dikmans, 1931
Mesocestoides latus Mueller, 1927	Small intestine	Illinois	Mueller, 1930
		Wisconsin	Rausch and Tiner, 1949
		California	Voge, 1953
		Pennsylvania	Blumenthal and Kirkland, 1976
		Illinois	Present study
Mesocestoides variabilis Mueller, 1927	Small intestine	Mississippi	Byrd and Ward, 1942
		Mississippi	Byrd and Ward, 1943
		Illinois	Babero, 1957
		Georgia	Babero, 1960
		North Carolina	Miller and Harkema, 1970
		Georgia	Stewart and Dean, 1971
		North Carolina	Feldman et al., 1972
Oochoristica sp. Luhe, 1898	Small intestine	Illinois	Leigh, 1940
Spirometra mansonoides Mueller, 1935	Small intestine	Louisiana	Corkum, 1966
Nematoda			
Anatrichosoma buccalis Pence and Little, 1972	Gums and buccal muscosa	Louisiana	Pence and Little, 1972
		Costa Rica	Pence and Little, 1972
		Florida	Kinsell and Winegarner, 1975
Aspidodera harwoodi Chandler, 1932	Cecum	Texas	Chandler, 1932
Capillaria sp. Zeder, 1800	Lungs	North Carolina	Sherwood et al., 1969
		Georgia	Prestwood et al., 1977
		Louisiana	Brow, 1988
Capillaria didelphis Butterworth and Beverley-Burton, 1977	Lungs	North Carolina	Miller and Harkema, 1970
		North Carolina	Feldman et al., 1972
		Norht Carolina	Feldman and Self, 1973
		Georgia	Nettles et al., 1975
		Georgia	Butterworth and Beverley-Burton, 1977
		Virginia	Snyder et al., 1991
		Illinois	Present study
Capillaria longicauda Freitas and Lent, 1935	Esophagus	Georgia	Babero, 1960
		N. Carolina	Feldman et al., 1972
		Illinois	Present study
Cruzia americana Maplestone, 1930	Large intestine	Texas	Chandler, 1932
		Illinois	Leigh, 1940
		Ohio	Crites, 1956
		Illinois	Babero, 1957

Table 2. Continued.

Species	Anatomical location	Geographic locality	Reference
		Georgia	Babero, 1960
		Virginia	Holloway and Dowler, 1963
		Virginia	Holloway, 1966
		North Carolina	Miller and Harkema, 1970
		Georgia	Stewart and Dean, 1971
		North Carolina	Feldman et al., 1972
		North Carolina	Feldman and Self, 1973
		Georgia	Nettles et al., 1975
		Pennsylvania	Blumenthal and Kirkland, 1976
		Georgia	Prestwood et al., 1977
		Virginia	Snyder et al., 1991
		Illinois	Present study
Cruzia tentaculata Rudolphi, 1819	Large intestine	Pennsylvania	Canavan, 1929
		Louisiana	Dikmans, 1931
		Pennsylvania	Canavan, 1931
		Texas	Chandler, 1932
		Tennessee	Reiber and Byrd, 1942
		Wisconsin	Rausch and Tiner, 1949
		North Carolina	Sherwood et al., 1969
		Mexico	Lamothe et al., 1981
Didelphonema longispiculata (Hill, 1939) Wolfgang, 1953	Stomach	Oklahoma	Hill, 1939b
		Georgia	Stewart and Dean, 1971
Didelphostrongylus hayesi Prestwood, 1976	Lung pleura	Georgia	Prestwood, 1976
		Georgia	Prestwood et al., 1977
		Georgia	Anderson et al., 1980
		Louisiana	Brown, 1988
		Tennessee	Duncan et al., 1989
Dipetalonema didelphis Esslinger and Smith, 1979	Esophageal connective tissue	Georgia	Babero, 1960
		North Carolina	Feldman et al., 1972
		Louisiana	Esslinger and Smith, 1979
Dipetalonema pricei Vaz and Pereira, 1934	Connective tissue	Pennyslvania	Blumenthal and Kirkland, 1976
Dirofilaria sp. Railliet and Henry, 1911	Heart	Georgia	Babero, 1960
		North Carolina	Feldman et al., 1972
Dracunculus sp. Reichard, 1759	Connective tissue	Canada	Crichton and Beverley-Burton, 1973
Gnathostoma sp. Owen, 1836	Stomach	Louisiana	Dikmans, 1931
		Texas	Chandler, 1932
		Georgia	Babero, 1960
		Georgia	Stewart and Dean, 1971
Gnathostoma didelphis Chandler, 1932	Liver	Pennsylvania	Canavan, 1929
		Pennsylvania	Canavan, 1931
		Georgia	Babero, 1960
		Georgia	Flores-Barroeta et al., 1961
		Louisiana	Flores-Barroeta et al., 1961
Gnathostoma spinigerum Owen, 1836	Stomach	Georgia	Babero, 1960
		Pennsylvania	Blumenthal and Kirkland, 1976
Gongylonema longispiculum Schults, 1927	Esophagus	Georgia	Babero, 1960
Lagochilascaris sprenti Bowman, 1983	Stomach	Louisiana	Bowman et al., 1983
Lagochilascaris turgida (Stossich 1902) Travassos, 1924	Stomach	Pennyslvania	Canavan, 1931
Longistriata didelphis (Travassos, 1914) Travassos and Darriba, 1929	Small intestine	Louisiana	Dikmans, 1931
		Illinois	Leigh, 1940
		Tennessee	Reiber and Byrd, 1942
		Maryland	Dikmans, 1943
		Illinois	Babero, 1957
		Georgia	Babero, 1960
		North Carolina	Miller and Harkema, 1970

Table 2. Continued.

Species	Anatomical location	Geographic locality	Reference
		Georgia	Stewart and Dean, 1971
		North Carolina	Feldman et al., 1972
		North Carolina	Feldman and Self, 1973
		Illinois	Present study
Oesophagostomum sp. Molin, 1861	Lungs	Louisiana	Dikmans, 1931
Physaloptera turgida Rudolphi, 1819	Stomach	Pennsylvania	Canavan, 1929
		Louisiana	Dikmans, 1931
		Pennsylvania	Canavan, 1931
		Texas	Chandler, 1932
		Kansas	Haley, 1938
		Oklahoma	Hill, 1939a
		Illinois	Leigh, 1940
		Tennessee	Reiber and Byrd, 1942
		New York	Stoner, 1945
		Wisconsin	Rausch and Tiner, 1949
		New York	Hamilton, 1951
		Illinois	Babero, 1957
		New York	Babero, 1960
		Georgia	Krupp, 1962
		Texas	Hamilton, 1963
		Virginia	Holloway and Dowler, 1963
		Colorado	Krupp and Quillin, 1964
		Virginia	Holloway, 1966
		North Carolina	Sherwood et al., 1969
		North Carolina	Miller and Harkema, 1970
		Georgia	Stewart and Dean, 1971
		North Carolina	Feldman et al., 1972
		Georgia	Nettles et al., 1975
		Pennsylvania	Blumenthal and Kirkland, 1976
		Georgia	Prestwood et al., 1977
		Louisiana	Green, 1980
		Mexico	Lamothe et al,. 1981
		Florida	Gray and Anderson, 1982
		Tennessee	Duncan et al., 1989
		Virginia	Snyder et al., 1991
		Illinois	Present study
Strongyloides sp. Grassi, 1870	Small intestine	Louisiana	Contacos, 1954
		Louisiana	Little, 1966
Toxocara canis Werner, 1782	Stomach decomposed	Pennsylvania	Blumenthal and Kirkland, 1976
Trichinella spiralis Owen, 1835	Diaphragm tongue	Iowa	Zimmerman et al., 1956
		Iowa	Zimmerman et al., 1959
		Virginia	Solomon and Warner, 1969
		Florida	Scholtens and Norman, 1971
		Pennsylvania	Schad et al., 1984
		New Jersey	Leiby et al., 1988
Trichostrongylus sp. Loos, 1905	Lungs	Louisiana	Dikmans, 1931
Trichuris sp. Roederer, 1761	Cecum	Louisiana	Dikmans, 1931
		North Carolina	Miller and Harkema, 1970
		North Carolina	Feldman et al., 1972
		North Carolina	Feldman and Self, 1973
Trichuris didelphis Babero, 1960	Cecum	Georgia	Babero, 1960
Trichuris marsupialis Foster, 1939	Cecum	Georgia	Stewart and Dean, 1971
Trichuris minuta Rudolphi, 1819	Cecum	Georgia	Babero, 1960
		Colorado	Krupp and Quilin, 1964
Viannaia hamata Travassos, 1914	Small intestine	North Carolina	Miller and Harkema, 1970
		North Carolina	Feldman et al., 1972
		North Carolina	Feldman and Self, 1973
Viannaia viannai Travassos, 1914	Small intestine	Maryland	Dikmans, 1943

Table 2. Continued.

Species	Anatomical location	Geographic locality	Reference
Trematoda			
Alaria marcianiae (La Rue, 1917) Walton, 1949	subcutaneous fat and lungs	Louisiana	Shoop and Corkum, 1981a (mesocercarial stage)
Amphimerus pseudofelineus Ward, 1901	Ducts of liver and gall bladder	Illinois	Leigh, 1940
Brachylaima didelphus Premvati and Bair, 1979	Small intestine	Florida	Premvati and Bair, 1979
Brachylaima virginiana Dickerson, 1930	Small intestine	Virginia	Dickerson, 1930
		Louisiana	Dikmans, 1931
		Texas	Chandler, 1932
		Maryland	Krull, 1935
		Illinois	Leigh, 1940
		Tennessee	Byrd et al., 1942a
		Wisconsin	Rausch and Tiner, 1949
		Illinois	Babero, 1957
		Georgia	Babero, 1960
		Virginia	Holloway and Dowler, 1963
		Louisiana	Kaplan, 1964
		Virginia	Holloway, 1966
		North Carolina	Miller and Harkema, 1970
		North Carolina	Feldman et al., 1972
		North Carolina	Feldman and Self, 1973
		Georgia	Nettles et al., 1975
		Pennsylvania	Blumenthal and Kirkland, 1976
		Georgia	Prestwood et al., 1977
		Louisiana	Shoop and Corkum, 1981b
		Louisiana	Shoop and Corkum, 1982
		Illinois	Present study
Didelphodiplostomum variabile (Chandler, 1932) Dubois, 1945	Small intestine	Texas	Chandler, 1932
		Illinois	Leigh, 1940
		Tennessee	Byrd et al., 1942a
		Illinois	Babero, 1957
		Georgia	Babero, 1960
		North Carolina	Miller and Harkema, 1970
		North Carolina	Feldman et al., 1972
		Florida	Premvati and Bair, 1979
		Illinois	Present study
Echinostoma trivolvis Cort, 1914	Small intestine	Louisiana	Dikmans, 1931
		Oklahoma	Park, 1936
		Illinois	Leigh, 1940
		Tennessee	Byrd et al., 1942a
		Wisconsin	Rausch and Tiner, 1949
		North Carolina	Feldman et al., 1972
		Pennsylvania	Blumenthal and Kirkland, 1976
		Illinois	Present study
Fibricola cratera (Barker and Noll, 1915) Dubois, 1932	Small intestine	Tennessee	Byrd et al., 1942a
		Michigan	Chandler and Rausch, 1946
		Wisconsin	Rausch and Tiner, 1949
		Florida	Premvati and Bair, 1979
		Louisiana	Shoop and Corkum, 1981b
		Louisiana	Shoop and Corkum, 1982
Fibricola lucida (LaRue and Bosma, 1927) Dubois and Rausch, 1950	Small intestine	Texas	LaRue and Bosma, 1927
		Louisiana	Dikmans, 1931
		Oklahoma	Park, 1936
		Tennessee	Byrd et al., 1942a
		Illinois	Babero, 1957
		Louisiana	Lumsden and Zischke, 1961
		Louisiana	Kaplan, 1964
		Florida	Premvati and Bair, 1979
		Louisiana	Shoop and Corkum, 1982

Table 2. Continued.

Species	Anatomical location	Geographic locality	Reference
Heterobilharzia americana Price, 1929	Mesenteric venules	Louisiana	Kaplan, 1964
		Louisiana	Shoop and Corkum, 1981b
Linstowiella szidati Anderson, 1944	Small intestine	Louisiana	Lumsden and Winkler, 1962
		Louisiana	Shoop and Corkum, 1982
Maritreminoides nettae (Gower, 1938) Rankin, 1939	Small intestine	North Carolina	Miller and Harkema, 1970
Paragonimus kellicotti Ward, 1908	Lungs	Georgia	McKeever, 1958
		North Carolina	Sherwood et al., 1969
		North Carolina	Feldman et al., 1972
		Louisiana	Shoop and Corkum, 1982
Paragonimus rudis (Diesing, 1850) Stiles and Hassall, 1900	Lungs	Mexico	Lamothe et al., 1981
		Mexico	Lamothe et al., 1986
Paragonimus westermani (Kerbert, 1878) Braun, 1899	Lungs	Tennessee	Byrd, 1941
		Tenneessee	Byrd et al., 1941
		Tennessee	Byrd et al., 1942b
		Illinois	Present study
Phagicola lageniformis (Chandler, 1941) Morozov, 1952	Lungs	Florida	Premvati and Bair, 1979
Rhopalias macracanthus Chandler, 1932	Small intestine	Louisiana	Dikmans, 1931
		Texas	Chandler, 1932
		Illinois	Leigh, 1940
		Tennessee	Byrd et al., 1942a
		Oklahoma	Self and McKnight, 1950
		Illinois	Babero, 1957
		Georgia	Babero, 1960
		Louisiana	Lumsden and Zischke, 1961
		North Carolina	Miller and Harkema, 1970
		Georgia	Stewart and Dean, 1971
		North Carolina	Feldman et al., 1972
		North Carolina	Feldman and Self, 1973
		Florida	Premvati and Bair, 1979
		Louisiana	Shoop and Corkum, 1981b
		Louisiana	Shoope and Corkum, 1982
		Illinois	Present study
Strictodora cursitans Holliman, 1961	Small intestine	Florida	Kinsella and Heard, 1974
Zonorchis allentoshi (Foster, 1939)	Gallbladder	Texas	Denton, 1944

iabilis (Table 2). At this time, the specific rank of these tapeworms has been questioned, and morphological differences between the 2 are indistinct. In fact, there is a great deal of variability in both the hosts and the morphology, causing even further confusion.

Nematoda

Capillaria didelphis Butterworth and Beverley-Burton, 1977

Adult *C. didelphis* were found encysted in lung tissue such that yellow patches appear just beneath the surface. The finding of this species in the Illinois opossum constitutes a new locality record. The genus *Capillaria* Zeder, 1800, contains numerous species that parasitize virtually all classes of vertebrates. Representatives of this genus have been reported as parasites of the digestive tract, respiratory system, genitourinary tract, and subcutaneous tissues of various North American mammals (Read, 1949).

Capillaria longicauda Freitas and Lent, 1935

In a typical infection, there was only one *C. longicauda* worm present per animal. The finding of this species in Illinois represents a new locality record for this host. Previous to this survey, this parasite has only been reported from the opossum in Georgia (Babero, 1960) and North Carolina (Feldman et al., 1972).

Because over 50% of the hosts examined in this survey were infected with this parasite, one can conclude that it is a rather common helminth in opossums. The paucity of reports may be due to the small size and often obscure location of

infection. These nematodes are long and slender and burrow into the mucosa of the esophagus, forming several intertwining loops and making removal difficult.

Cruzia americana Maplestone, 1930

Normally, *C. americana* resides in the cecum; however, upon the death of the host, they usually migrate to other regions of the intestinal tract. This species is one of the most common helminths in the opossum, with reported findings from numerous states (Table 2). In addition to *C. americana,* there have been numerous reports of *C. tentaculata* Rudolphi, 1819, in the Virginia opossum from several states and *C. cameroni* in opossums from Trinidad (Wolfgang, 1951).

Nettles et al. (1975) examined a debilitated opossum from Georgia and reported a large number of *C. americana.* They asserted that despite this seemingly innocuous appearance, *C. americana* in sufficient numbers could interfere with host nutrition. In conjunction with other helminths, this species may produce some degree of debilitation.

Longistriata didelphis (Travassos, 1914) Travassos and Darriba, 1929

Longistriata didelphis are red-colored in vivo because they feed on the blood of the host. They are rather small, tightly coiled worms that possess a moderately expanded cuticle with very fine transverse striations. Reports of *L. didelphis* are common in the opossum, as demonstrated by the plethora of published accounts in numerous localities throughout North America (Table 2).

Despite their prevalence in this survey, there was no sign of inflammation or other gross tissue destruction. Feldman et al. (1972) reported that there seemed to be little host response to this parasite. The results of this survey suggest that the opossum can adapt to its presence rather easily.

Physaloptera turgida Rudolphi, 1819

There have been more than 30 reports of *P. turgida* in the opossum, and nearly every publication surveying helminths of this host has mentioned its presence. This species seems to be present throughout the range of the Virginia opossum. Adult worms were always concentrated in a large group along the greater curvature of the stomach near the fundus, producing a large fibrous ulceration at the point of attachment. It has additionally been surmised that the ulcerations produced in the gastric epithelium may open up avenues for infection by bacteria (Sherwood et al., 1969). Larvae of the nematode parasite *Lagochilascaris* sp. may use these openings as a migration route as well (Smith et al., 1983). Adults of *L. sprenti* can be found encysted in the lungs, brain, mesentery, and muscle tissue.

Food studies on the opossum (Hamilton [1951] in New York and Stieglitz and Klimstra [1962] in Illinois) note the importance of grasshoppers and beetles as food items. These insects are a likely intermediate host for this helminth.

Trematoda

Brachylaima virginiana Dickerson, 1930

Brachylaima virginiana was the most prevalent trematode found in this survey, a trend reflected in the literature with more than 20 reports of its presence from approximately 10 states. In addition to the opossum, there have been reports of *B. virginiana* in the mink, *Mustela vison,* and the skunk, *Mephitis mephitis* (Yamaguti, 1958).

Didelphodiplostomum variabile (Chandler, 1932) Dubois, 1945

One opossum from a marshy area had an intense infection, suggesting that this particular host fed primarily on snails and amphibians and consequently harbored a very large number of adult parasites. *Didelphodiplostomum variabile* is one of several common trematode parasites in the opossum. Reports of *D. variabile* have been cited in most surveys. Several authors disagree about the generic placement of this species; even the establishment of this genus was questioned for some time. Adults within the subfamily Diplostominae Monticelli, 1888, are usually found in fish-eating birds (Shoop, 1989); however, adults in several genera are known to occur in mammals. The genus *Didelphodiplostomum* was erected to account for their presence in mammals rather than birds. Chandler and Rausch (1946) disagreed because substantial morphological differences were absent, and the debate has continued since. Harris et al. (1967) called for the suppression of *Didelphodiplostomum,* arguing that host specificity cannot be relied upon.

Shoop (1989) presented a systematic analysis of the strigeoid trematodes and asserted that the considerable adult similarities are typical of this group. The phylogeny suggests that this group originally infected reptiles and then radiated to

birds. The final step in their evolution resulted in the infection of mammals, which was accomplished by shifting the second intermediate host from fish to amphibians. Shoop (1989) concluded that these genera are valid, based primarily on body shape, citing the degree of separation of the anterior and posterior body regions as the major criterion.

Echinostoma trivolvis Cort, 1914

Echinostoma trivolvis is a rather uncommon helminth of the opossum, having been reported only from a few states. This species is a cosmopolitan parasite and shows little host specificity, as it is known to occur in waterfowl, muskrats, terrestrial birds, and beavers. Because it is associated with aquatic and semiaquatic vertebrates, its low prevalence (in only 2 animals) is reflected by the fact that most of the opossums in this study were collected from wooded habitats.

Due to variability in its life cycle, *E. trivolvis* can mature in numerous vertebrate hosts, and as a result of the distinct physiology of a given definitive host, considerable morphological variation exists in the adult form. This has given rise to a number of descriptions of new species within this genus. Beaver (1937) was able to discount several of these species and synonymized close to 15 forms under the name *E. revolutum.* More recently, this has been determined to be incorrect, and the current name, *E. trivolvis,* is now in use (Huffman and Fried, 1990).

Paragonimus westermani (Kerbert, 1878) Braun, 1899

Previous to the present survey, *P. westermani* had only been reported in the opossum from Tennessee. The finding of this species constitutes a new locality report for this host.

There has been a great deal of taxonomic difficulty surrounding this genus. In the opossum, there have been reports of *P. kellicotti* in Georgia, North Carolina, and Louisiana (Table 2). Additionally, *P. rudis* (Lamothe et al., 1981) is known to occur in the opossum in Mexico. *Paragonimus westermani* infects a number of vertebrate hosts including the mink (Olsen, 1974), its normal definitive host, as well as dogs, cats, and humans. Because the mink is considered to be the normal host for this helminth, its presence in the opossum demonstrates that the opossum feeds on crayfish, the second intermediate host.

Ameel (1934) originally described the life cycle and discussed the taxonomy of this genus. To differentiate these species, Ishii (1966) placed great importance on the nature of the tegumental spines, egg morphology, and construction of the testes. The most conclusive way to differentiate the adults of *P. westermani* and *P. kellicotti* is through the examination of the ovary. Ishii (1966) observed that the branching of the ovary in *P. kellicotti* is more distinct and extensive than the ovary of *P. westermani,* which is less branched.

In the present study, the specimens reflect this simpler branching and are consistent with the description given by Byrd et al. (1942b). Although some authors believe these forms to be conspecific (Olsen, 1974), these specimens will be assigned to *P. westermani* until the taxonomic debate is resolved or until more substantial criteria for differentiation are established.

Rhopalias macracanthus Chandler, 1932

Rhopalias macracanthus is considered to be one of the few ubiquitous trematode parasites in the opossum in North America, having been reported from numerous localities. Characteristic of this genus are 2 retractable proboscises resting on either side of the oral sucker. These structures can protrude from their receptacles, allowing *R. macracanthus* to attach to the intestinal mucosa by means of 10 well-developed spines on each proboscis.

As observed in this study, the opossum harbors a diverse and sometimes intense helminth population. How these animals seem to thrive with the enormous burdens associated with heavy helminthic infections is unknown. This apparent adaptability to the presence of these parasites may give these animals an enhanced capacity to act as a reservoir for several species of helminths. The prevalence of these species in other mammals as well as the effects on the life expectancy and overall health of the hosts are not presently understood. Further research is needed to test for the presence of these helminths in other mammals in order to elucidate the role of the opossum in spreading disease.

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